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AUDIO WATER MARKING USING DISCRETE WAVELET TRANSFORM AND HAMMING WINDOWING TECHNIQUE

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ABSTRACT

Wireless networks expanded its applications in our day to day life. The wireless networks are open medium and hence are vulnerable to various security attacks. Here, we discuss about one of the multimedia data i.e., audio data. In this modern world audio watermarking is very much important in voice communication for real time application like transferring confidential information between officials to maintain secrecy etc., The practical challenges for watermarking includes requirement analysis, fast, robustness, imperceptibility and robustness. The watermarking applications can be divided into hardware based watermarking systems and software based watermarking systems. The watermarking hardware chip can be integrated with TV setup box, mobile phone, digital camera. The software based watermarking systems are more popular, easy to implement and cheaper. The general applications of watermarking includes copyright protection, authentication, fingerprinting, annotation watermarking, source tracking, integrity protection, broadcast monitoring, enforcement of usage policy. In this paper, an audio watermarking algorithm based on DWT and hamming windowing technique can be used for protecting intellectual properties from unauthorized copying is proposed. This paper deals about embedding an image into audio. The algorithm uses the discrete wavelet transform(DWT), image decomposition techniques and hamming windowing techniques. It embeds the watermarking pixel's value inside the wavelet coefficient of host audio. The watermarked audio signal and the original audio signal resembled each other closely. Experimental results illustrated that the proposed approach is able to withstand the various security attacks..

***KEYWORDS:** Audio Watermarking, Copyright Protection, Discrete Wavelet Transform & Hamming Window*

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Original Article

INTRODUCTION

In this modern world, with the development of wireless network, multimedia files, especially audio, image, and video data is used in human society. Some multimedia data including economics, entertainment, industry, politics, education, etc., are needed to be protected by providing integrity, confidentiality, and ownership. Digital data will be easily copied without authorization. To prevent this, many algorithms are proposed. Digital watermarking is the efficient solution to deal with unauthorized copying.

Digital Watermarking means embedding a secret information into a cover signal (i.e., audio, image, or video file) so that no one except the authorized recipient even knows that the message is sent. Audio water - marking is the method of embedding data in an audio signal in order to protect the copyright of its content without affecting the audio'squality.

Digital watermarking is classified into two types depends on domain, i.e., Frequency domain and Spatial domain

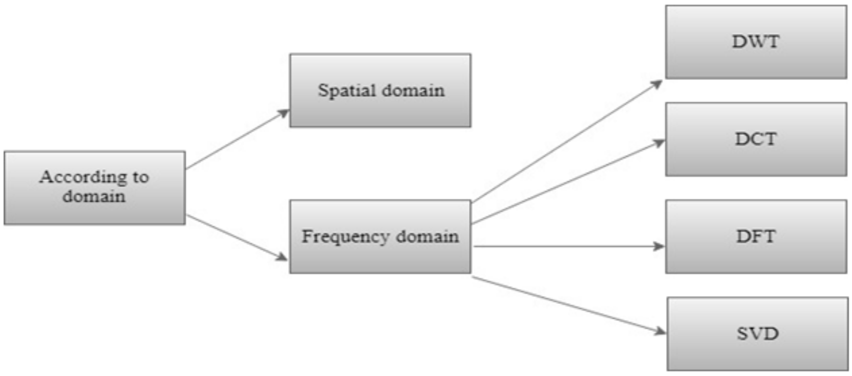


Figure 1: Types of Watermarking

Algorithm applied in the frequency domain are more robust than those applied in spatial domain. Hence, researchers prefer frequency domain than spatial domain. The individualistic of Human Visual System (HVS) can be represented more accurately by the frequency coefficients than spatial coefficients. Frequency domain is divided into DWT, DCT, DFT and SVD. Many people prefer DWT in water marking than DCT and DFT, because DWT has the property 'multi resolution multilevel transform'. So that DWT can able to understand HVS closer than other transform techniques.

PRELIMINARIES

Discrete Wavelet Transform

The discrete wavelet transform (DWT) is an implementation of wavelet transform that decomposes the signal into a mutually orthogonal set of wavelets. The DWTtools can be used for signal processing such as noise reduction, peak detection, data compression and so on. It captures both frequency and location information(in time).

The wavelet is a wavefunction of the signal. It is obtained by applying sampling techniques on signal, and set of wavelet function is achieved. Many wavelet functions which can be derived from their mother wavelet functions.

$$\Psi_{x,y}(t) = \frac{1}{\sqrt{x}} \Psi\left(\frac{t-y}{x}\right) \tag{1}$$

Where,

x is said to be scaling factor and y is said to be shifting parameter of mother wavelet signal function. There are different kinds of wavelet function. They are:- i) Morlet wavelet, ii) Daubechies wavelet, iii) Continuous wavelet, iv) Haarwavelet. The basic principle of DWT is to factorize the poly-phase matrix of a wavelet filter into a sequence of alternating upper and lower triangular matrices and diagonal matrices.

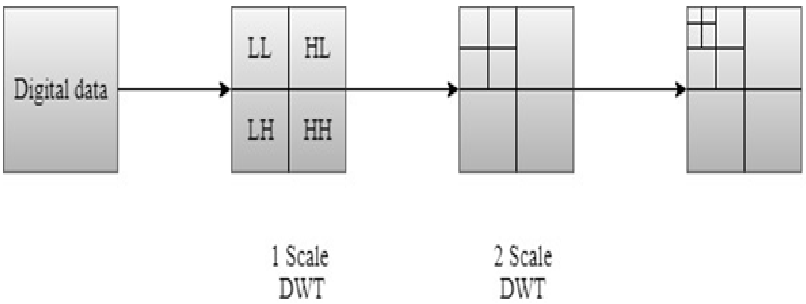


Figure 2: DWT Levels

Based on equation (1), this technique separates the digital data into various sub bands. The DWT bands explained in Figure 2. The Approximation coefficient (LL) band gives the more significant magnitude value of DWT coefficient at each level of decomposition, and other bands (HL, LH, HH) give the small amount of ratio.

The advantages of using wavelet transform:- i) Representation of functions which is having discontinuities and sharp peaks. ii) Signals can be stored more efficiently than by Fourier transform. iii) Accurately deconstructing and reconstructing non-stationary, finite and non-periodic signals. iv) Providing a way for analyzing waveforms in both frequency and duration. The DWT has a vast number of applications in mathematics, science, engineering and computer science. Practical applications are data and image compression, noise reduction, partial differential equation solving, pattern recognition, texture analysis and transient detection.

Hamming Windowing Technique for Signal Processing

The Hamming window has sinusoidal shaped signal representation. It can do better work of eliminating the near rest side lobe. This type of window function is used in noise measurements. It won't reach zero and hence still has a slight discontinuity in the signal. This type of window was proposed by Richard W. Hamming. The window is upgraded to minimize the maximum (nearest) side lobe and thereby giving a height of about one-fifth that of the Hannwindow.

$$\boldsymbol{\omega(n) = \alpha\text{-}\beta \cos (2\pi n/ N\text{-}1)} \tag{2}$$

with

$\alpha = 0.54$, $\beta = 1-\alpha = 0.46$

Instead of both constants being equal to 1/2 in the Hannwindow. The constants are approximations of values $\alpha = 25/46$ and $\beta = 21/46$. This cancels the first side lobe of the Hannwindow by placing a zero at frequency $5\pi/(N - 1)$. Approximation of constants to two decimal places considerably lowers the level of side lobes, to a nearly equiripple condition. In the equirip presence, the optimal values of the coefficients are $\alpha = 0.53836$ and $\beta = 0.46164$.

Zero-Phase Version:

$$\omega_0(n) = \omega(n + N\text{-}1/2) \tag{3}$$

$$= 0.54 + 0.46 \cos\left(\frac{2\pi n}{N-1}\right) \tag{4}$$

PROPOSED FRAMEWORK

Key Selection

To increase confidentiality and integrity, water marking has to be done with Key. Only sender and receiver knows the key. The size of the key is 8 bits. Hence it improves the security. Without the Key, it is impossible to retrieve the information. Here, the key is between 0 to 255. It uses pseudo random sequence generator. Because the maximum pixel size is 255.

Embedding

- Read the input audio signal. It will gives the sample frequency of the audio.
- Apply Windowing technique (Hamming Windowing Method) to takes mall segments of audio. Because processing the entire audio will be difficult and then change it for entire audio.
- Apply Fast Fourier Transform (FFT) to convert the signal into a spectrum. The resulting data can be displayed in terms of a water fall plot.
- Apply Discrete Wavelet Transform (DWT) with sample frequency to decompose the spectrum according to frequency bands. The DWT will give four frequency bands (LL, LH, HL, HH).
- Take the higher frequency components for processing. Because the slight variation in the higher frequency components won't disturb the audio much.
- Before the image enrollment in the audio, embed the key with audio.
- Take the input image and apply preprocessing steps for image to remove noise.
- Decompose the image into separate clusters by using histogram. Separate the horizontal and vertical components and convert it into binary values.
- Now map the each bit with audio by using bit mapping techniques. Find the frequency ranges of audio and accordingly append the horizontal and vertical components of the image.
- Apply IDWT on the resultant spectrum to compose the data.
- Apply IFFT technique to convert the spectrum into an audio signal. The resultant is the watermarked audio.

  Now the water marked audio is ready to transmit.

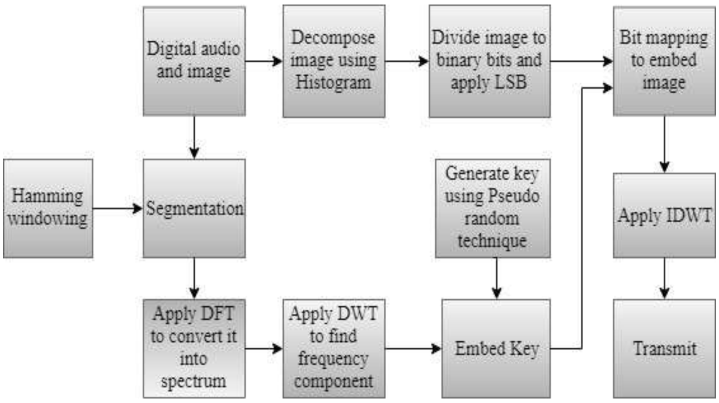


Figure 3: Embedding Algorithm

Extraction

- The initial process is same as embedding.
- Read the watermarked audio. Follow the same steps as in embedding up to step no.5.
- Then it verifies the key which is entered. It checks with the sender key whether it is correct or wrong.

- Apply the reverse process (i.e) In embedding pixels are mapped according to frequency range. But in extraction frequency bands are identified according to extracted horizontal and vertical bit values.
- At last pack the data into pixels and write the output image.

Now it is subjected to testing for quality analysis. Apply LSB similarity to analyze the similarity bit by bit.

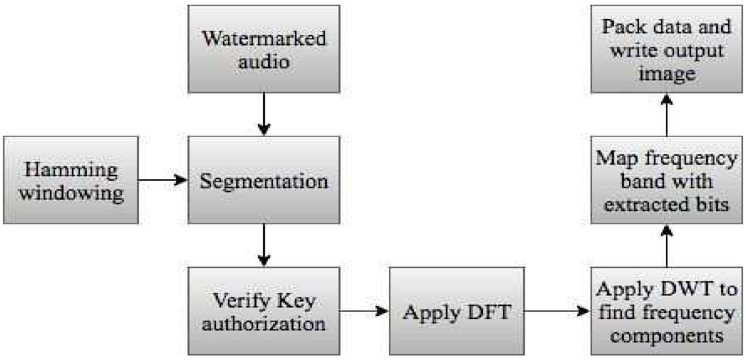


Figure 4 : Extraction Algorithm

EXPERIMENTAL RESULTS AND DISCUSSIONS

Here, the performance analysis for proposed scheme is presented. These will tell efficiency of the proposed scheme. The complete analysis of algorithm has done with the 150X150 image and evaluated with considering quality parameters. MATLAB software is used for simulation of this technique.

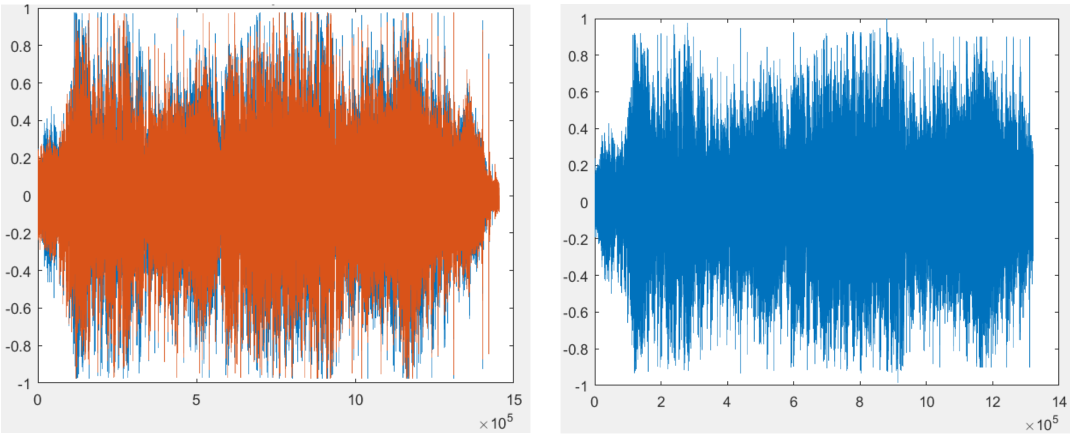
The quality of the image and watermarked audio can be measured by using Peak Signal To Ratio (PSNR) and Mean Square Error(MSE). PSNR is defined as the ratio between the maximum possible power of signal and power of corrupting noise that affects quality of its representation. MSE is the cumulative squared error between original and transmitted signal. The Structural Similarity (SSIM) index is a method for measuring similarity between original and compressed image. The SSIM index for the original image and extracted image is 0.71. The proposed scheme results:

Table 1

Properties	Image	Audio
MSE(R)	4.03	-
MSE(G)	3.42	-
MSE(B)	4.43	-
MSE	-	0.0
PSNR(R)	42.11	-
PSNR(G)	42.82	-
PSNR(B)	41.69	-
PSNR	-	80.91

Figure 5: (i) Original Image (ii)Extracted Image (iii) Original Image (iv) Extracted Image

The plot for original audio and watermarked audio isgivenbelow:



(i) Original Audio **(ii)Watermarked Audio**

Figure 6: Histogram for Original and Watermarked Audio

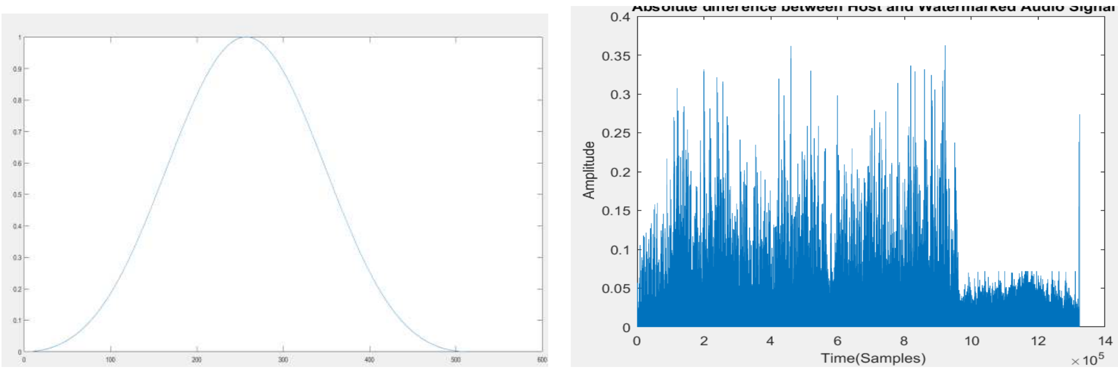


Figure 7: (i) Plot for Windowing **(ii) Absolute Difference between Original Audio and Watermarked Audio**

The compression quality factor is a number that determines the degree of loss for an image. The plot for compression quality factor is:

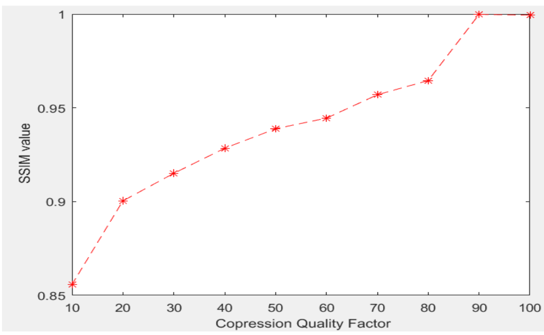


Figure 8

The correlation Coefficient is a measure of strength of the linear relationship between two variables. In the proposed scheme, the correlation coefficient for image is0.97 .

The experimental results are listed above. Therefore, it is clearly observed that our proposed scheme can work efficiently.

CONCLUSIONS

In this paper, an audio water marking algorithm is presented using DWT and hamming windowing technique. The watermark is embedded on the cover audio's DWT subbands. Simulation results show that the watermark image and the recovered image resemble each other. The quality of watermarked audio is also high. Hence the experimental results prove that the algorithm is robust against different kinds of attacks.

As a future work, we are planning to study other watermarking algorithms effects firstly on capacity. For a more considerable capacity increment of water mark, we are planning to use some other techniques which can efficiently work along with discrete wavelet transform.

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